TYPE-WRITING BY TELEGRAPH.[1]

ONE of the most interesting papers read during the last session of the Institution of Electrical Engineers was that by Mr. Donald Murray on setting type by telegraph. Strictly speaking, the title of the paper is something of a misnomer, as the apparatus described by Mr. Murray was constructed for type-writing rather than type-setting; but as the principle is equally applicable to the latter process, it is unnecessary to be too critical. This is specially the case as the instruments and method were originally designed for the automatic telegraphic operation of linotype machines, and it was only because commercial considerations indicated the greater importance of the solution of the problem of telegraphic type-writing that attention was more particularly devoted to this question.

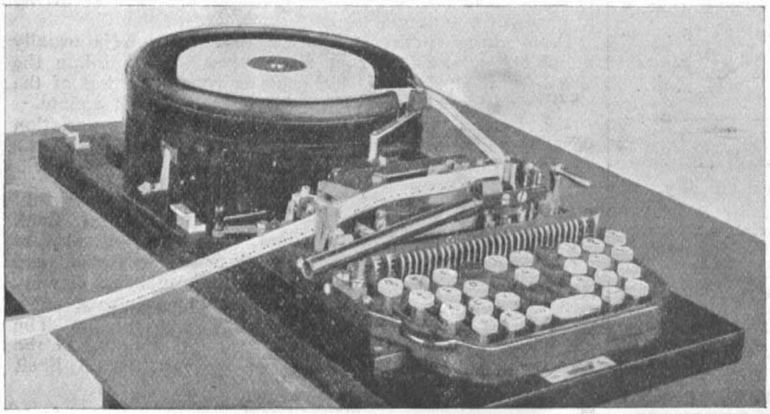

FIG. 1.—Keyboard Perforator with cover removed.

The problem which has to be solved is one of considerable complexity, as will readily be realised when its essential characteristics are considered. A message handed in at the transmitting station has to be translated into a series of signals which can be telegraphically transmitted over a single telegraph wire. These signals, on arriving at the receiving station, must actuate a receiving mechanism in such a manner that a particular set of signals produces a certain definite movement of the mechanism; thus the signals corresponding to the letter "a" must cause the striking (or equivalent) of the type-writer key "a," the signals corresponding to a notification of the end of a line must cause the shifting of the type-writer carriage ready for a new line, and so on. Now it is obvious that the signals as they are transmitted over the telegraph wire can only differ from each other by virtue either of their time arrangement or their magnitude. Each set of signals (corresponding to a letter) must be made up of one or more pulses of current, and one letter can only be distinguished from another by virtue of the pulses for the one being different in magnitude from those for the other, by their following one another at different intervals of time, or by their lasting for different periods of time; of course, also, a combination of any two or of all three of these may be used. It is not possible for the telegraphic signals to be differentiated in space unless more than one wire is used to connect the two stations. It is equally clear that the distinction between the signals in their final form is one of space, and this is so whether we consider the ultimate result, that is to say, the printed letter, or merely the alterations produced in the space relationship of the various parts of the printing mechanism which causes that mechanism instantaneously to print a particular letter. Thus we may say that what a type-writing telegraph has to do is the following:—it has to receive a message and translate it into a series of time or magnitude signals, to transmit these signals electrically over a wire, and to re-translate them into a series of space signals.

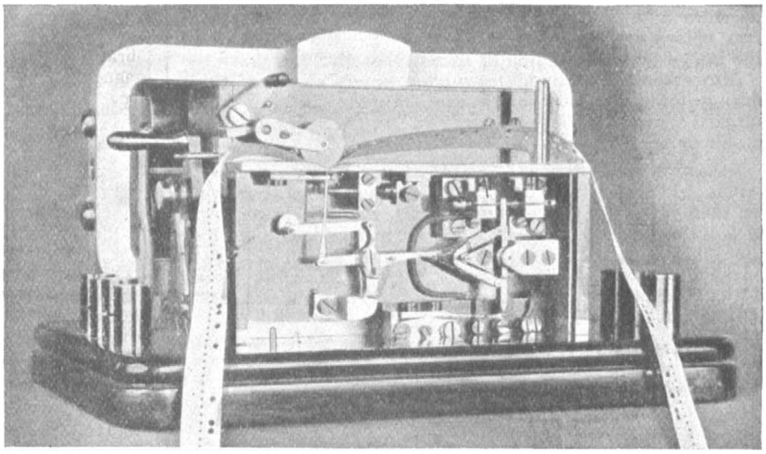

FIG. 2.—Single-line Transmitter.

We have had occasion during recent years to describe several systems of telegraphy which aim at doing much the same thing as the Murray telegraph attempts, and it is of interest to compare the transmission methods used in these. Thus in the telautograph (see NATURE, vol. lxiv. p. 107) the actual handwriting of the original message is transmitted and reproduced, and this is done by a combination of space and magnitude signals. Two wires are used, and current pulses of varying magnitudes sent along them which reproduce at the receiving end the motion of a pen at the transmitting station. Here the time element of the signals has no effect, and a letter is reproduced equally if it be traced in one second or in one hour. In the Pollak-Virag system (see NATURE, vol. lxiv. p. 7) the telegraphic signals produce the motion of a beam of light which records in Roman letters the message transmitted. In this system the telegraphic signals differ from one another in their space relation and their duration. In the Murray system the signals differ from one another in their time relation.

We have pointed out that the first process is the translation of the message into a series of time signals, and for this purpose a time signal alphabet has to be chosen. Though this may at first sight seem a matter of secondary importance, it is in reality hardly too much to say that upon the suitability of the alphabet selected will depend, more than upon anything else, the chances of success of the system. This fact has been thoroughly realised by Mr. Murray and others who have worked upon this problem, with the result that an alphabet has been finally devised which seems to possess in the greatest degree possible all the more important advantages. In it every letter or other signal which has to be transmitted is represented by a series of five time signals; the alphabet is therefore an "equal letter alphabet," that is to say, each letter is composed of the same number of signal units (five in this case). The average number of units per letter is, of course, five; in the Morse alphabet the average number is thirteen; there is therefore an apparent advantage in time over the Morse code, but this may be more apparent than real, as the unequal length of the letters in the Morse code enables the shorter ones to be chosen for those letters occurring with the greatest frequency (such as E and T), so that the average number of units per message may be less than in an equal letter alphabet having a smaller average number of units per letter. Thus experience has shown that the actual average number of units per letter with the Morse code is only eight instead of thirteen. It must be remembered, also, that the Morse code is intended primarily for hand signalling, and consequently when time intervals are used the difference between any two which have to be distinguished manually or by ear must be fairly great. Thus the Morse dot consists of one unit, the Morse dash of three; were two units used for the dash instead of three, the distinction between the dash and dot would not be sufficiently marked. With machine telegraphy, on the other hand, there is no need to make such a great differentiation between the signals, as time intervals of one, two, three, and more units can all be distinguished, and in consequence it is possible to devise a shorter alphabet than the Morse code. It is not to be denied, however, that the use of a new alphabet is undoubtedly a disadvantage from the practical point of view, as it has to be learnt by the operators. This drawback is minimised by the fact that the operator does not print each signal separately as in operating a transmitting key; but it is nevertheless desirable, if not essential, that he should be able to read the message when printed on the transmitting tape.

---

[1] "Setting Type by Telegraph." By Donald Murray. (*Journal of the Institution of Electrical Engineers*, vol. xxxiv., pp. 555. 1905).

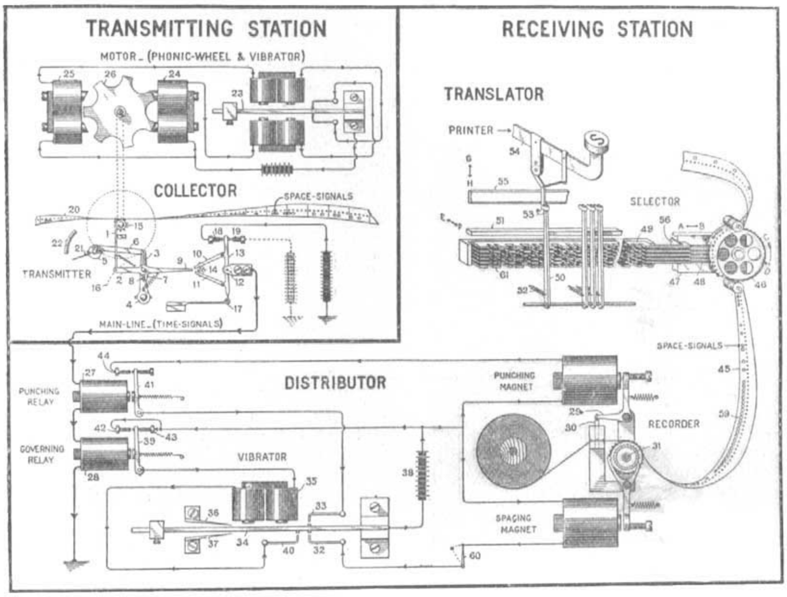

Fig. 3.—General Diagram of Murray Automatic Printing Telegraph System.

To turn now to the apparatus used in the Murray system; the first operation, as in all automatic telegraph systems, is to punch the message to be transmitted on a paper strip or "tape." This is done by means of a keyboard instrument of the ordinary type-writer form shown, with the cover removed, in Fig. 1. On the tape will be noticed a double row of holes, which can be seen more distinctly in Fig. 4; the row of small holes serves only to feed the tape forward, both in this machine and in the transmitter; the larger holes are the signals punched in the tape. The actual perforator can be seen in front; it is worked by an electromagnet which punches the necessary holes on the forward stroke and moves the tape one letter space (five holes) forward on its back stroke. On the right can be seen a lever which enables the tape to be pulled back letter by letter to make corrections; these are made by punching five holes, thus blotting out all the holes already punched, this signal (of five holes) leaving the receiving mechanism unaffected. It is thus possible to wipe out any part of the message incorrectly written on the tape, and so produce a tape which will give an absolutely correct message when transmitted; this is facilitated by the fact that the operator can see the tape as it is perforated, letter by letter. The speed at which this perforator can be worked is about 120 letters (twenty words) a minute. The transmission can be carried on five or six times as rapidly, so that five or six operators working at these perforators can produce enough tape to keep the transmission line full.

The automatic transmitter is shown in Fig. 2, and diagrammatically in Fig. 3 (collector). The tape is fed forward in the usual way by the star-wheel 15, passing across the end of an upright rod 1. This rod is pivoted as shown to the system of levers which oscillate about the centre 4, being kept in oscillation by the eccentric wheel 5, and making one oscillation for every unit on the tape. If this unit is a hole, the rod 1 enters this hole, the end 2 of the lever 2-9 is raised and the end 9 lowered, whereby the oscillation of the lever 3 brings the end 9 against the bar 11, thus pushing the contact lever 13 against contact 18. Here it remains until the next oscillation, and if this is the same as before, due to a second hole in the tape, it is not disturbed. It will thus be seen that successive signals of the same kind (either successive holes or successive spaces) are transmitted, not as intermittent, but as continuous signals. But if there follows a space in the tape the rod 1 cannot rise to its full height, the lever 2-9 is kept down at the end 2 and raised at the end 9, which comes in consequence against the rod 10 and forces the contact lever 13 over against contact 19, thereby breaking the punching current and sending spacing current into the line. The whole apparatus is driven by a phonic wheel motor in the usual way, the vibrating reed 23 sending currents alternately to the magnets 24 and 25, which keep the armature 26 in rotation. This is geared directly to the star-wheel 15, which has ten teeth, and is itself geared in the ratio of 10:1 to the eccentric wheel 5, so that the latter makes, as already stated, one revolution for every unit of the tape.

Now let us follow the message to its arrival at the receiving station, where the signals are caused to produce a second perforated tape, the exact duplicate of the first, by means of the mechanism grouped together in Fig. 3 under the title "distributor." The tape is fed forward unit by unit by means of the spacing magnet which operates the escapement 31, and holes are punched in the

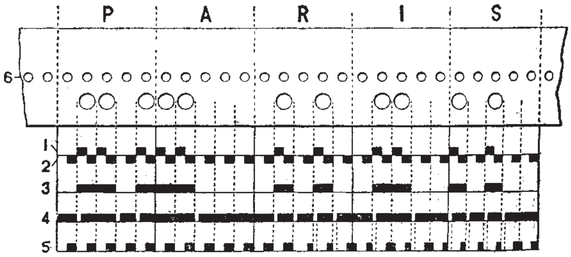

Fig. 4.

tape by the punch 30, which is operated by the punching magnet. If the circuits of these two magnets are followed out it will be seen that both are controlled by the vibrating reed 34 in such a way that they operate alternately according as the reed is against contact 32 or 33. It will further be seen that the punching magnet is also controlled by the punching relay 27, the circuit being open in the position shown, and closed when the reed 41 is against contact 44, *i.e.* when punching current is coming through the main line and punching relay. It will be noticed at once that the distributor cannot work properly unless the tongue 41 of the punching relay is in synchronism with the reed 34. To obtain this synchonism is the object of the governing relay 28, which is operated by the line current. The tongue of this relay vibrates between the contacts 42 and 43; when it is in contact with either the circuit of the vibrator magnet is closed, but during its passage from one to the other this circuit is opened. If this occurs whilst the contact 40 is open it can obviously have no effect on the oscillations of the reed, but if it occurs whilst this contact is closed it has the effect of diminishing the duration of the current in the vibrator magnet. The reed 34 vibrates against two springs 36 and 37, so that its time of vibration is capable of great control by the magnitude of the current in the vibrating magnet. By setting it so that its natural speed is a little too high, it is possible by means of the controlling action of the governing relay for perfect synchronism to be obtained. The action will perhaps be more readily understood by the diagram, Fig. 4. This shows a piece of the transmitting tape at the top punched with the signals for the word "Paris." In line 1 are shown the current impulses to the punching magnet due to the simultaneous closing of contacts 33 and 44. In line 2 are the regular intermittent current impulses to the spacing magnet due to the closing of contact 32. Line 3 shows the main line signals which, as pointed out in explaining the method in which the transmitter acts, are continuous and not intermittent. Line 4 shows the interruptions in the circuit of the vibrator magnet caused by the vibration of the reed of the governing relay which occurs at the beginning and end of every signal in line 3. In line 5 are the actual current pulses in the vibrator magnet due to the closing of contact 40. These are shown in step at the beginning, but gradually falling out of step, whereby, as will be seen, they are diminished by the interruptions shown in line 4, and are thus automatically brought back into step.

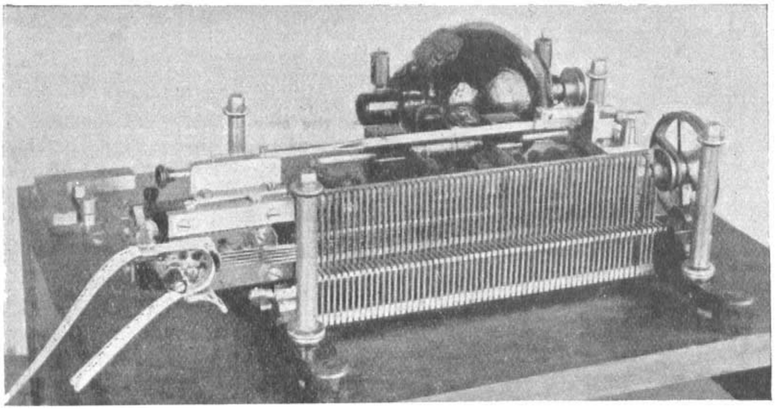

Fig. 5.—Murray Printer with Typewriter removed.

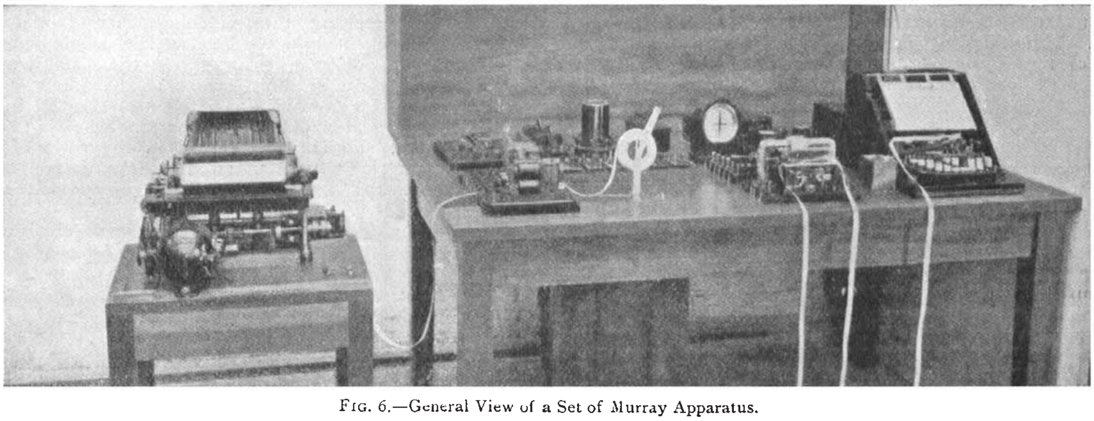

Fig. 6.—General View of a Set of Murray Apparatus.

The only remaining operation is to use the tape 45 (Fig. 3) to work either a type-writer or a type-setting machine. The Murray printer with the type-writer removed is shown in Fig. 5, and diagrammatically in Fig. 3. It will not be necessary to describe it in detail; the principle is that of the ordinary lock and key. The tape is fed forward letter by letter by means of the star-wheel 46; the reciprocating shuttle 47 carries a die block, which allows the five rods 48 to pass through the perforations in the tape when these are present. According as one or more of these rods passes through the tape, a particular set of slots in the combs, 49, attached to the rods is brought into line, the corresponding lever 50 is pulled into the channel thus formed, and the corresponding type-writer key is depressed.

The complete set of Murray apparatus is shown in Fig. 6. On the extreme right is the perforator, next to it on the left the automatic transmitter, then on the same table the distributor in front and the relays behind. The translator and type-writer are on the small table at the left. We have only been able to give a brief description of the most important features of this very ingenious system; there are numerous points of detail which space does not permit us to describe. The system has been on trial for some time both in this country and abroad, and has met with considerable success; it is now in use on several English lines. There can be no question after the perusal of Mr. Murray's paper that it possesses many advantages over its forerunners which should enable it to survive. It is stated that the automatic part of the apparatus can be run perfectly up to 200 words (1200 letters) a minute, but that no type-writer will stand the strain of being run at this speed, a maximum of 120 words being all that is allowable. It is, however, obviously possible to run the automatic part at top speed if necessary, and use two type-writers at the receiving end in the same way as at the transmitting end.

Maurice Solomon.